The development of AWE's neutron spectrometry capability in support of the NCSP's Integral Experiments

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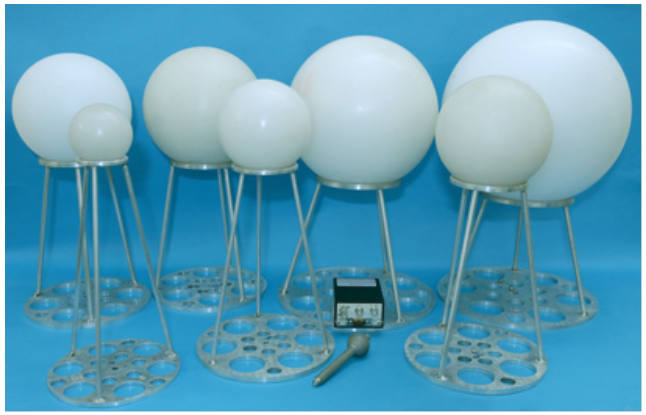
Introduction

- Regulatory requirement for performance tests or inter-comparisons of nuclear accident dosimetry;
- In 2011 LLNL invited AWE to participate in the planned inter-comparison using Godiva;

- LLNL asked for help to establish reference values in the Godiva radiation field at NCERC.

Existing capability in 2011

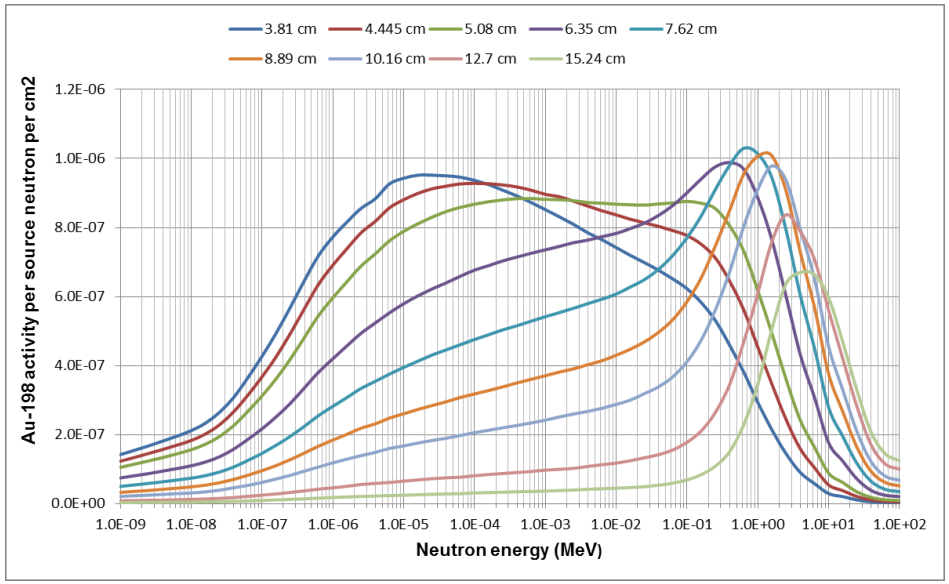
- Traditional Bonner sphere spectrometer with He-3 proportional counter;
- ROSPEC neutron spectrometer;
- Off-the-shelf γ-ray spectrometers;
- Cannot be used in pulsed fields.

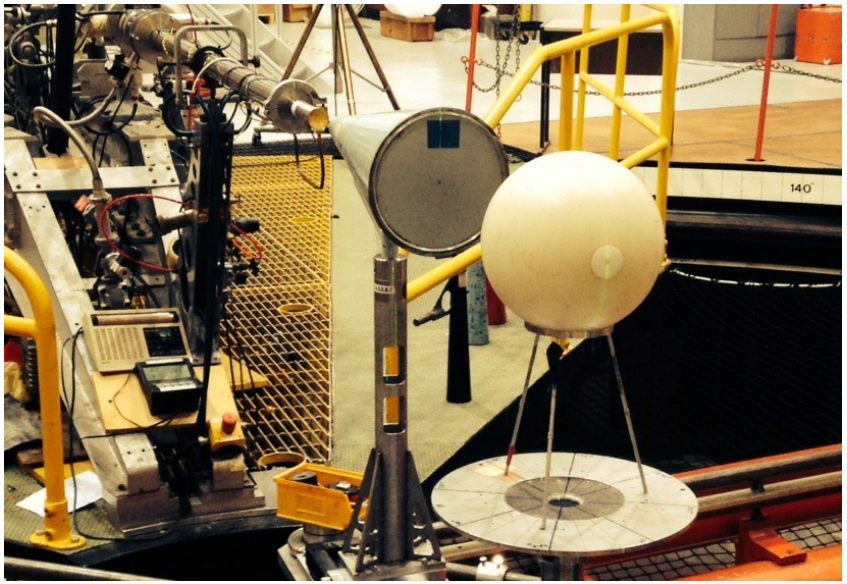


New capabilities required.

Passive Bonner Sphere Spectrometer

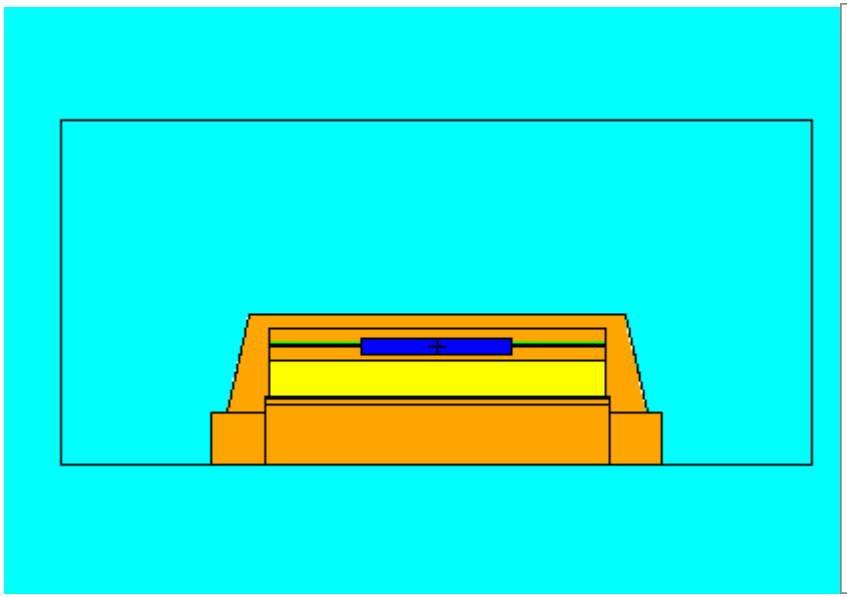
- Capability Key Event in CY14 (Apr ‘13 – Mar ‘14) to develop and validate the pBSS;
- Computational modelling and experimental validation.

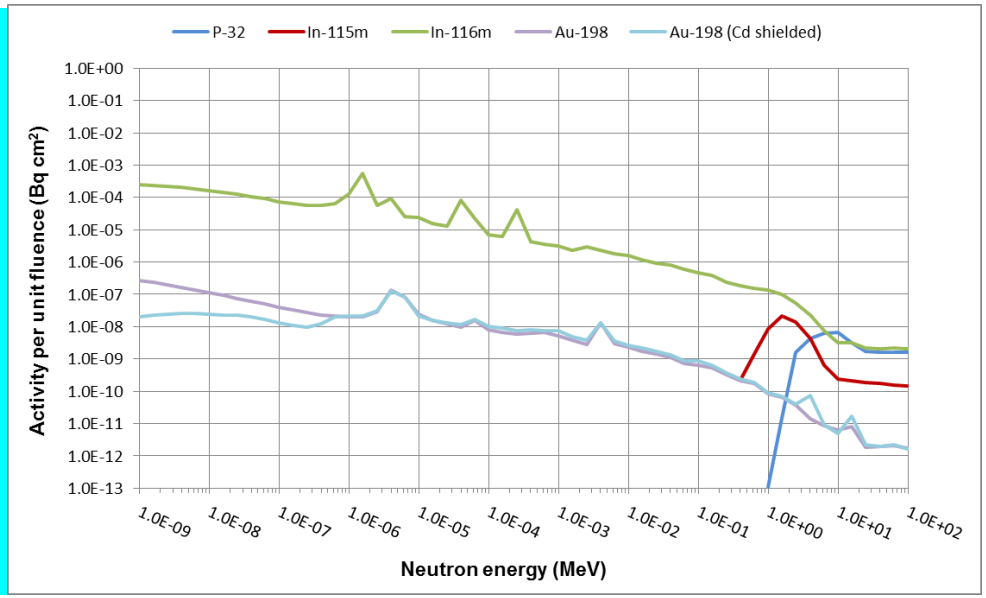




Enhanced NADs

- Development based on unfolding techniques;
- Multiple detector elements with unique response functions.





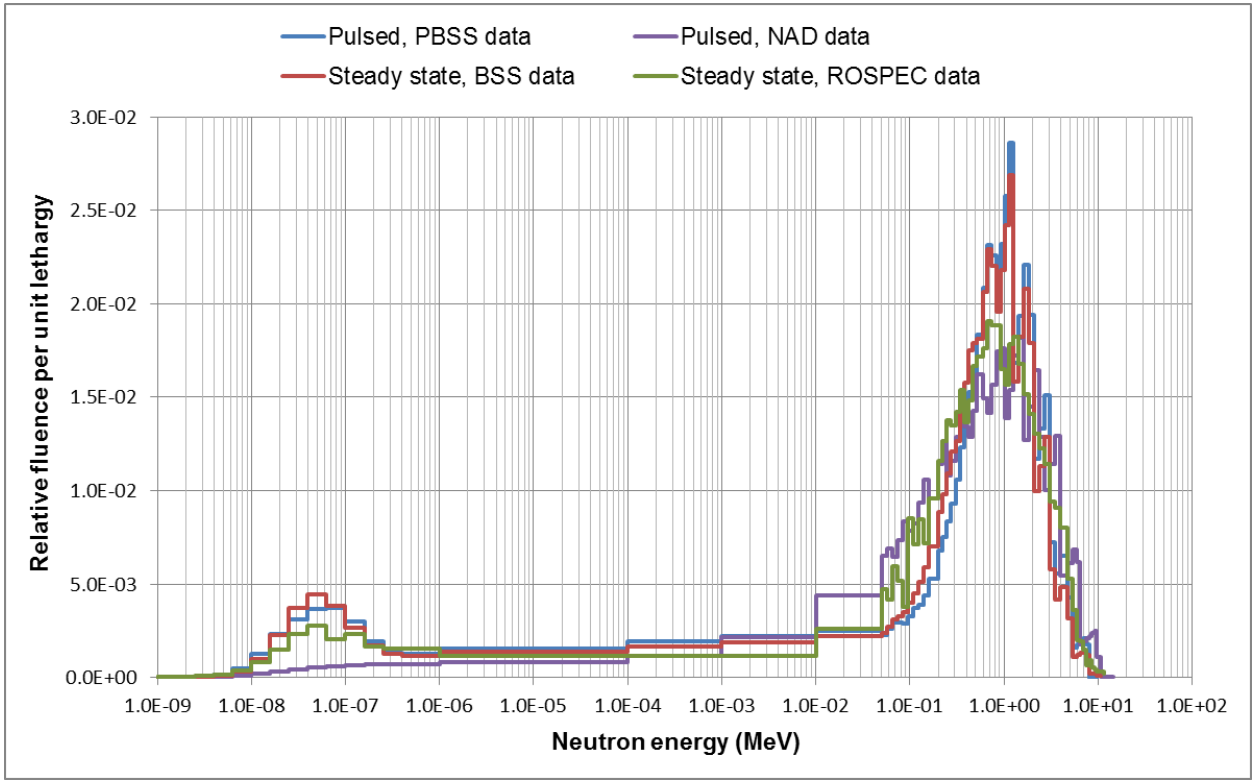
Measurements of Godiva-IV at NCERC

- "Steady-state" campaign in Nov 2013, AWE provided;
  - Bonner sphere spectrometer;
  - ROSPEC.

- "Burst" campaign in May 2014, AWE provided;
  - Enhanced NADs;
  - pBSS.

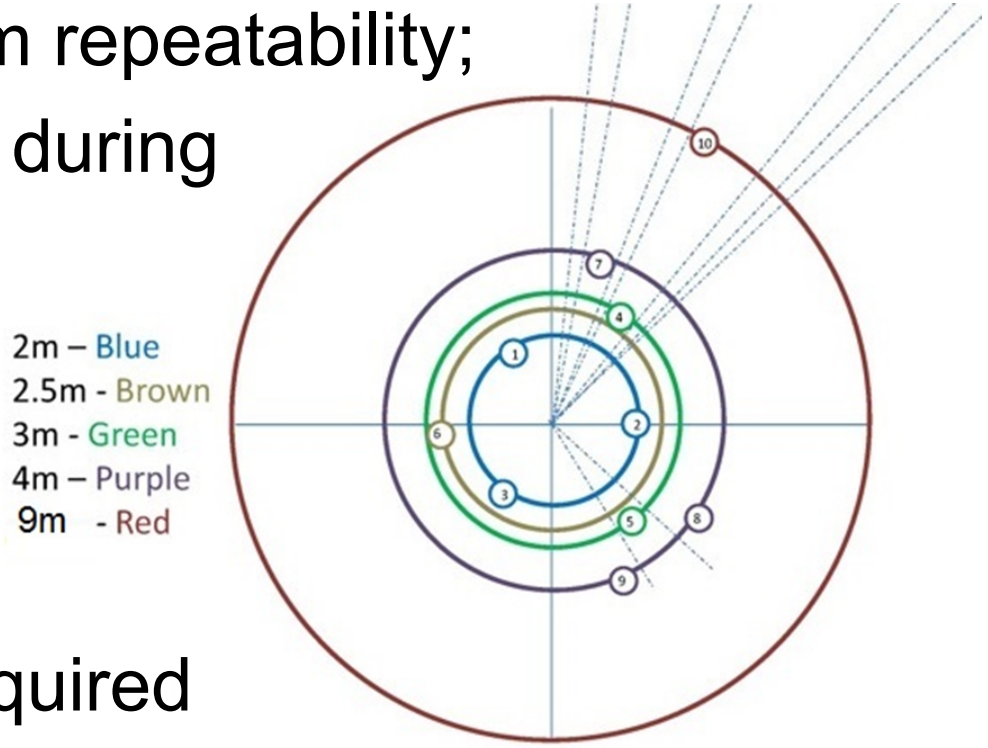
Measurements of Godiva-IV at NCERC

- Good agreement between various measurement techniques (see presentation by Dave Hickman).



Limitations of pBSS

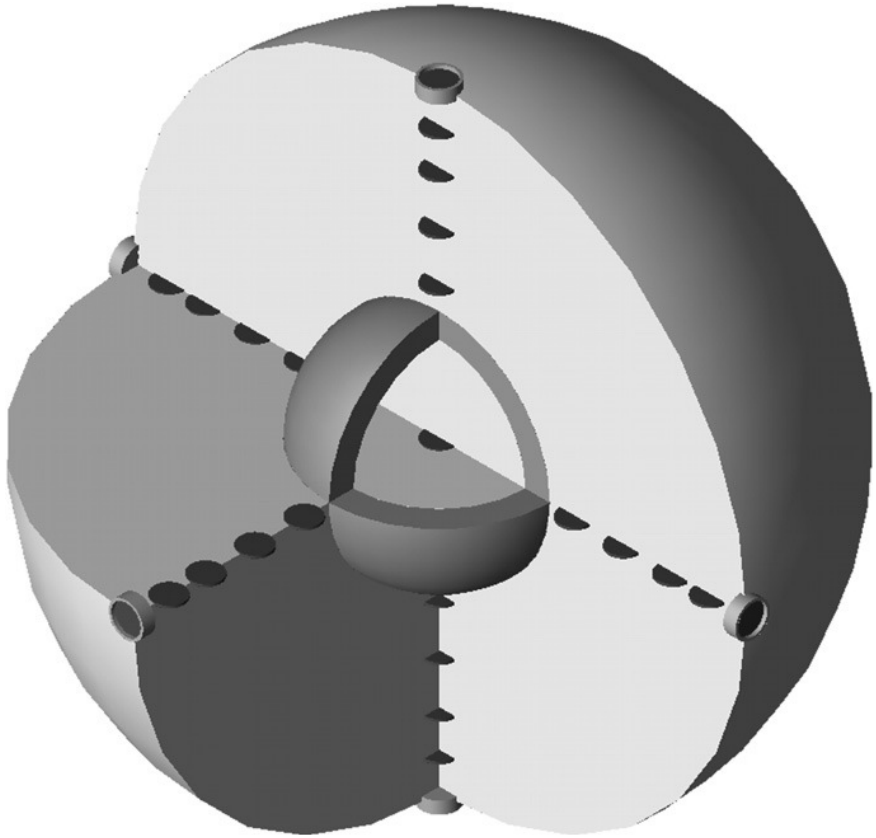
- 9 bursts required for measurement of a single reference point;
- Uncertainty arising from repeatability;
- Exposure of personnel during setup.



New capabilities required

Single sphere spectrometer

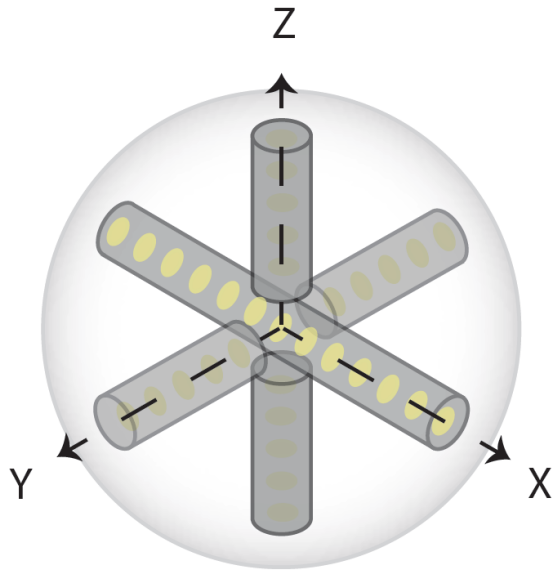
- Variation on Bonner-sphere method;
- Single moderator containing multiple detector elements;
- Only one exposure required for a complete neutron spectrum.

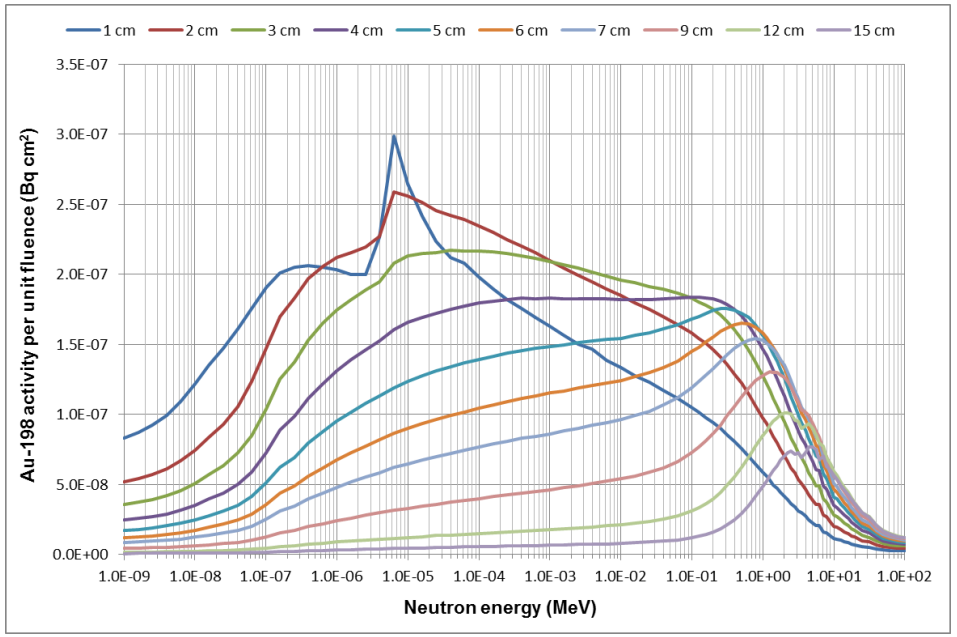


Gomez-Ros, J. M., Nucl. Inst. Meth. A 677 (2012) pp. 4-9

AWE single sphere spectrometer

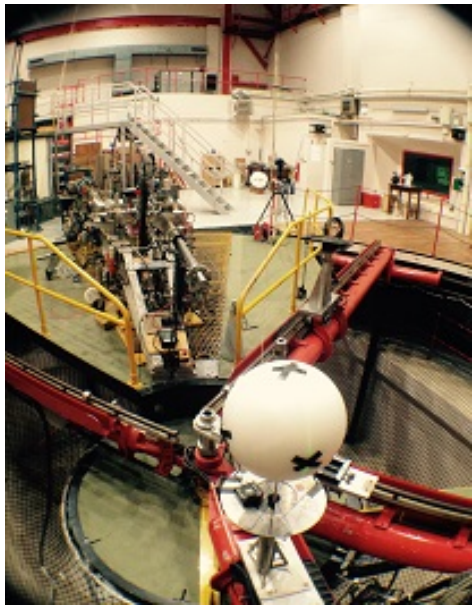
- Development of single sphere design containing 55 gold foils;
- The depth of each foil was optimised for an un-collided fission spectrum using MCNP6.

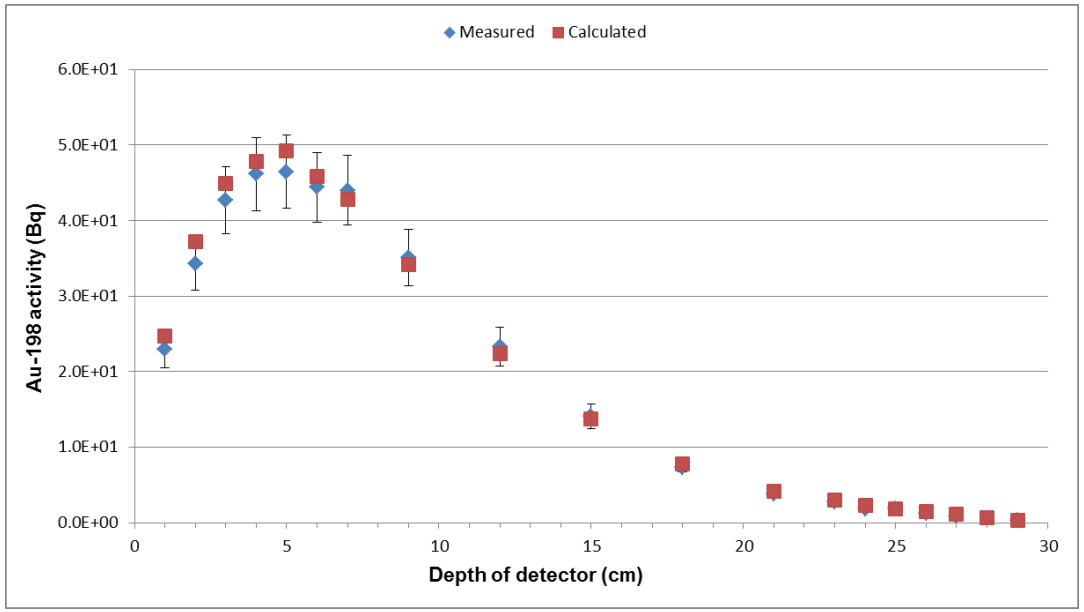




Validation of the single sphere

- Prototype manufactured in April ‘14;
- Future Technologies funding secured in Nov ’14 for 4 new detectors and experimental validation;





Future support to NCERC

- 3 x Passive Single-Sphere Neutron Spectrometers (pSSNS) will be loaned to LLNL for use at NCERC (Godiva and Flattop);
- Current unfolding capability will be enhanced so that directional components of neutron spectrum can be determined;
- Equipment has been procured to investigate a method for embedding active detectors in the single sphere.

Acknowledgements

- Leo Clark, AWE;
- Dave Heinrichs, John Scorby, Dave Hickman, Jennifer Burch, Becka Hudson, Andrew Wysong (and all the LLNL support crew at NCERC);
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